

## PREPARING TEACHERS TO ENGAGE STUDENTS FOR EQUITABLE MATHEMATICS EDUCATION

Robert Q. Berry, III  
University of Arizona  
rqberry@arizona.edu

*Preparing teachers to teach mathematics is at the intersection of the three areas where cultural and racial knowledge intersects with content and pedagogical content knowledge. Consequently, preparing teachers to teach mathematics must consider all peoples' practices. This highlights two Black girls marginalized by their teacher, which provides the space for discussing teacher discretion and systemic violence. A significant takeaway when preparing teachers is to get them to think about how they can lead with mathematics rather than violence.*

Keywords: Equity, Inclusion, and Diversity; Classroom Discourse; Teacher Educators

### **Preparing Teachers: Content, Pedagogy, & Cultural and Racial Knowledge**

Mathematics teacher education has often concentrated on equipping teachers with the necessary skills to address three key areas: (a) the content of mathematics they should teach, (b) knowledge of pedagogy for teaching mathematics, and (c) the qualifications required for teaching mathematics (Berry et al., 2014). Teachers should have deep knowledge of mathematics content, which correlates positively to students' achievement (Howard & Milner, 2021). Additionally, teachers should know the pedagogy for teaching mathematics or mathematical knowledge for teaching, which is positively related to teachers' use of effective mathematics teaching practices (Ottmar et al., 2015). By focusing on these three areas, too often, preparing teachers to engage in equitable mathematics teaching receives minimal attention. There is widespread agreement among professional organizations in the field of mathematics education that preparing teachers to develop equitable frameworks in their teaching is necessary for addressing inequities in students' experiences (Association of Mathematics Teacher Educators, 2020; National Council of Teachers of Mathematics, 2014, 2018, 2020A, 2020B). Martin (2019) argued that there is still a considerable amount of effort required to establish equitable and inclusive access to mathematics education for those who have been historically excluded and disenfranchised.<sup>1</sup>

Teachers who teach students from historically marginalized and disenfranchised populations should not only be prepared to understand mathematics content and pedagogy but should also be prepared to understand ways of using their students' racial and cultural backgrounds in their teaching. Howard and Milner (2021) highlight three areas of knowledge for preparing teachers for equitable education: (a) content knowledge, (b) pedagogical content knowledge, and (c) cultural and racial knowledge. Preparing teachers to teach mathematics is at the intersection of the three areas where cultural and racial knowledge intersects with content and pedagogical

---

<sup>1</sup> When I use historically excluded and disenfranchised, I am not ascribing a sweeping set of attributes to Black, Latinx, Indigenous, and poor peoples. I understand that collapsing these groups into one group does not acknowledge the intersectionality within these groups. However, there are shared histories and experiences among historically excluded and disenfranchised people.

content knowledge. Consequently, preparing teachers to teach mathematics must consider all peoples' practices, including African, Indigenous, and non-Westernized perspectives (Mukhopadhyay et al., 2009). Building relationships and considering the practices of all peoples are described by many researchers as building on students' "funds of knowledge." Funds of knowledge encompass various aspects of people's lives, such as cultural experiences, artifacts, values, emotions, language, and identity (Moll & Gonzalez, 2004).

An example is provided by Civil and Khan (2001), who delved into teaching practices to establish a connection between students' familial and cultural experiences and mathematics content. These works all question the belief that teaching mathematics is culturally neutral and that there is a set of universally accepted teaching practices. Consequently, preparing teachers to teach mathematics must elicit frameworks for making meaningful connections between teaching with students' cultures, lives, and experiences.

The vignette below highlights the importance of making meaningful connections between teaching with students' cultures, lives, and experiences. The vignette focuses on the role of mathematical discourse as a pedagogical practice intersecting with Black girls' experiences and ways of knowing. Specifically, the Black girls, Alexa and Jasmine, are marginalized by their teacher, which provides the space for discussion of teacher discretion and systemic violence due to the girls being marginalized.

#### **Vignette: Alexa and Jasmine**

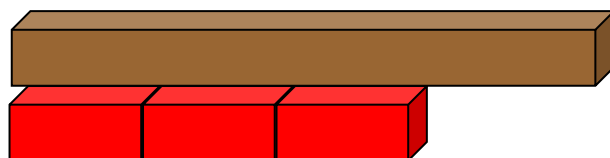
Ms. Lewis, a fourth-grade teacher, uses Cuisenaire Rods to make sure her students understand the concepts of unitizing (treating an object as a unit or whole), partitioning (separating a unit/whole into equal parts), and iterating (repeating a part to produce identical copies of it) (McCloskey & Norton, 2009). In previous grades and lessons, students used Cuisenaire Rods to compare fractions, add fractions with like denominators, and subtract fractions with like denominators. In this lesson, Ms. Lewis builds on the previously learned concepts to introduce adding fractions with unlike denominators. She starts by saying, "If the brown rod is the whole, how might we solve  $\frac{1}{2} + \frac{1}{4}$ ?"

The students worked on the problem individually and then in pairs. Alexa and Jasmine, two Black girls, paired up to share their work and thinking with one another. Alexa's representation of the problem is below.



Alexa stated, "since brown is the whole, purple is one-half because two purples make a brown, and red is one-fourth because four reds make a brown."

Simultaneously, Jasmine explains her representation below.



Jasmine stated, “the purple is the same as two reds, so two reds are one-half. That is the same as two-fourths. So, you put another red, and the answer is three-fourths.” The discussion between the girls continued, with both working to make sense of the representations and convince each other why their representation made more sense.

Alexa and Jasmine were talking and referencing their representations simultaneously in a dynamic rather than a linear pattern. Their voices were elevated, and they expressed themselves nonverbally using hand gestures. While making her rounds to the pairs in the classroom, Ms. Lewis said to Alexa and Jasmine, “Ladies, one at a time.” There was no acknowledgment of their mathematical representation or the content of what was said.

When it was time for the whole group class discussion, Alexa and Jasmine enthusiastically raised their hands to share but were not acknowledged. After three students shared, Ms. Lewis presented a second task. “If the blue rod is the whole, how might you solve  $\frac{2}{3} + \frac{2}{9}$ ?”

Alexa decided not to engage with the task, and Jasmine spent much time trying to get Alexa to do the task. Alexa asked, “Why should I do it? . . . she not gonna call on us.” Jasmine responded, “that don’t matter . . . come on, just do it.” After a few moments, Ms. Lewis made her rounds to Alexa and Jasmine and noted that neither had started the second task. Ms. Lewis stated, “I need you, ladies, to get started and follow directions.” Jasmine started representing the task with the Cuisenaire Rods, while Alexa decided not to engage.

As I reflect on Alexa and Jasmine’s positioning in Ms. Lewis’ classroom, I wonder if the girls’ discourse pattern was perceived as not competent. As a result, Alexa felt marginalized and disconnected. What if Ms. Lewis had led by getting a sense of the girls’ mathematics understandings, rather than focusing on the ways the girls were engaging? If Ms. Lewis had taken this approach, would Alexa have continued to stay engaged throughout the lesson? Alexa and Jasmine’s discourse patterns are informed by their experiences within the Black community. This chapter challenges readers to examine the intersections between discourse patterns informed by communal experiences, teaching practices, and systemic violence.

### **Mathematical Discourse, Systemic Violence, and Discretionary Spaces**

There is widespread agreement on the role of mathematical discourse in positively impacting students’ mathematical experience. Promoting and valuing students’ participation in mathematical discourse is a way of positioning them as mathematically competent (Berry, 2018). Mathematical discourse involves several practices, such as asking and answering questions, exchanging mathematical representations and ideas, and constructing, evaluating, and refining arguments, among other methods. The use of mathematical discourse practices allows students to demonstrate their mathematical understanding and to connect with other students. However, mathematics teachers must be mindful of how focusing on discourse practices to the exclusion of mathematical and cultural understanding and experiences can position students as incompetent. In the vignette, Ms. Lewis focused on discourse without acknowledging Alexa and Jasmine’s mathematical understanding. She responded to how the girls engaged in discourse rather than their mathematical understanding reflected in their discourse.

Even when focusing on mathematical understanding for discourse, students may be positioned as “at-risk.” For example, constructing viable arguments and critiquing others’ reasoning are practices used in mathematics teaching that might have risk-taking implications for students. Constructing viable arguments and critiquing others’ reasoning are practices that, when performed outside the mathematics classroom, may put historically excluded students,

specifically Black students, at risk of negative consequences. When Black students construct arguments and critique the reasoning of those in authority or engage in this practice outside of mathematics classrooms, educators must consider the potential consequences. Argumentation may involve the projection of voice, tone, positioning of bodies, and proximity. These forms of engagement may be considered deficit if there is little understanding of social and cultural contexts for argumentation. In preparing teachers it is important to convey that there may be teaching practices that position students as “at-risk.”

The potential risk for Black students engaging in argumentation occurs when their ways of engagement do not align with expected norms for participating in this type of discourse, creating the potential for negative consequences. Alexa and Jasmine’s discourse patterns were not aligned with Ms. Lewis’ expectations for students’ participation in discourse. Many Black students come from communities where argumentation is non-linear and can be perceived as loud and aggressive, with several people talking simultaneously while engaging with one another. The assumption may be that no listening is occurring if multiple people are talking simultaneously. Such an assumption ignores the experiences and resources students bring from their communities. This argumentation pattern is inconsistent with turn-taking, where one person speaks while others listen, with everyone using “inside voices.” Policing argumentation based on assumptions and a specific pattern of discourse ignores that students may be highly engaged in mathematics. Understanding the assumptions and argumentation patterns helps teachers recognize that discourse in some communities is dynamic and multi-tiered.

Research in mathematics education reveals that Black students often face devaluation, inequity, exclusion, and violence (Battey, 2013; Berry, 2008; Joseph et al., 2019; Martin, 2015; McGee & Martin, 2011). In everyday language, “violence” is primarily defined as physical aggression against a person or group (Leonardo, 2013). In this context, violence is used to describe the emotional and psychological acts occurring in spaces where students feel disconnected and marginalized. Although this type of violence may not result in physical harm, it is still considered as such due to its detrimental effect on an students emotional and psychological well-being. The experiential aspects of violence in mathematics for historically excluded students can result in teaching and learning that lead to little or no engagement in activities that promote reasoning. In the second task in the vignette, Alexa chose not to participate because she felt she had not been acknowledged for her mathematical thinking, resulting in her feeling disconnected. An argument can be made that in this scenario, Alexa experienced violence.

Many Black students come to schools and classrooms with contexts rooted in the culture and traditions of the Black experience (Berry, 2020). Consequently, educators must know and understand Black students’ resources and find ways to incorporate these into mathematics teaching and learning. Considering Alexa and Jasmine’s perspectives in the vignette, it is plausible that their discourse pattern might be rooted in their cultural context and familiar traditions. Unfortunately, classroom teaching practices too often ignore context and traditions familiar to students and default to normalizing whiteness as the source of standard practices. This does not imply that all such practices are detrimental to Black students; however, it is necessary to understand how classroom practices differentially impact students’ experiences.

Teachers make daily decisions in classrooms that have a significant impact on their students’ experiences. According to Ball (2018), these decisions are made in what he refers to as “discretionary spaces.” In mathematics, discretionary spaces include but are not limited to task selection, means of engagement, positioning of students, and decisions about discourse. Ball

(2018), argues that discretionary spaces are driven by both policies and the autonomous discretion of teachers. For example, policy-driven practices might require specific teaching practices and resources, test preparation strategies for standardized tests, and standardizing content coverage through the narrow use of a pacing guide. The tensions between policy-driven teaching practices and teacher autonomy create what Ball (2018) described as a paradox of constraint and discretion in teaching.

Constraint teaching while positioned to disrupt inequities, can also restrict teachers' use of their professional judgment through standardization, and impede efforts to make schools contextually and culturally responsive. Discretion in teaching can make it possible to teach in contextually sensitive and culturally responsive ways and enable teachers to connect the school to the world, but it can also allow marginalization and other forms of oppression to flow into schools. Thus, Ball's (2018) paradox suggests that there are nuanced spaces necessary for both constraint and discretion in teaching to address systemic violence.

Ms. Lewis used a district-level mandated curriculum in her classroom that incorporated many teaching strategies supported by the National Council of Teachers of Mathematics (NCTM, 2020). For example, the curriculum incorporated mathematical discourse strategies that encourage students to provide reasoning and justifications for their mathematical thinking. While one can argue that using the curriculum and its materials are policy-driven, implementing those practices was at Ms. Lewis' discretion. It was clear that Ms. Lewis followed the basic outline of the lesson as prescribed in the curriculum materials. However, her decision not to acknowledge Alexa and Jasmine was at her discretion. The paradox is that the curriculum was designed to provide a high-quality mathematics experience for students, but the implementation can lead to disconnection and marginalization.

Every classroom is fertile with opportunities to elevate or stifle students through various modes of participation, valuing their thinking, and building community. Ball (2018) unpacks micro-moments in which teachers send implicit and explicit messages to students through decisions made in discretionary spaces. For some students, discretionary spaces serve as a source of systemic violence. Systemic violence can address behavior, position students' mathematical competency, and relate to culture and language in mathematics teaching. One way to disrupt systemic violence is to focus on students' humanity, cultural ways of knowing, and experiences that can create opportunities for engagement through mathematical discourse.

### **Leading with Mathematics**

Let's ponder how the lesson would have been different if Ms. Lewis had focused on mathematics instead of how Alexa and Jasmine engaged with one another. Instead of saying, "Ladies, one at a time," what if Ms. Lewis had said, "Tell me about your representation" or "Describe your Cuisenaire Rods"? These questions suggest that leading with mathematics creates opportunities for both the teacher and the learner. One major takeaway from the vignette when preparing teachers is to get them to think about how they can lead with mathematics rather than violence. Leading with mathematics focuses on pedagogical choices that position students as competent, experts, and safe. Teachers use questions to elevate students' mathematical thinking and representations rather than focusing solely on behaviors and how students are engaging in discourse while excluding mathematics. Positioning students as competent, experts, and safe demonstrates the discretionary spaces teachers use as part of their professional judgment to diminish and eliminate systemic violence and psychological, cultural, and spiritual harm to students. When teachers engage in discourse practices to support positive identity development, build community, and give students autonomy to engage in mathematics using the resources they

bring to the classroom, they can reflect on the impact of their practices on students' well-being. Reflecting on this vignette should push mathematics teacher educators to consider how to prepare teachers to use spaces of discretion.

## References

- Association of Mathematics Teacher Educators (AMTE). (2020). Standards for Preparing Teachers of Mathematics:(black+ White Version). Information Age Publishing, Incorporated.
- Ball, D. L. (2018, April). Just dreams and imperatives: The power of teaching in the struggle for public education. In Presidential Address to the American Educational Research Association Annual Meeting, New York (Vol. 19).
- Berry, R. Q., III. (2008). Access to upper-level mathematics: The stories of successful African American middle school boys. *Journal for Research in Mathematics Education*, 39(5), 464–488.
- Berry, R. Q., III. (2018, July). Positioning students as mathematically competent [NCTM blog post]. [https://www.nctm.org/News-and-Calendar/Messages-from-the-President/Archive/Robert-Q\\_-Berry-III/Positioning-Students-as-Mathematically-Competent/](https://www.nctm.org/News-and-Calendar/Messages-from-the-President/Archive/Robert-Q_-Berry-III/Positioning-Students-as-Mathematically-Competent/)
- Berry, R. Q., III. (2020, February). How do we help teachers teach math to Black kids? My response [NCTM blog post]. [https://www.nctm.org/News-and-Calendar/Messages-from-the-President/Archive/Robert-Q\\_-Berry-III/February-2020/](https://www.nctm.org/News-and-Calendar/Messages-from-the-President/Archive/Robert-Q_-Berry-III/February-2020/)
- Berry, R. Q., III, Ellis, M. & Hughes, S. (2014). Examining a history of failed reforms and recent stories of success: Mathematics education and Black learners of mathematics in the United States. *Race Ethnicity and Education*, 17(4), 540–568. doi:10.1080/13613324.2013.818534.
- Civil, M., & Khan, L. H. (2001). Mathematics instruction developed from a garden theme. *Teaching Children Mathematics*, 7(7), 400 – 405.
- Howard, T. C., & Milner, H. R. (2021). Teacher preparation for urban Schools. In H. R. Milner & K. Lomotey (Eds.), *Handbook of urban education* (2nd ed., pp. 221–237). Routledge.
- Joseph, N. M., Hailu, M. F., & Matthews, J. S. (2019). Normalizing Black girls' humanity in mathematics classrooms. *Harvard Educational Review*, 89(1), 132–155.
- Leonardo, Z. (2013). The story of schooling: Critical race theory and the educational racial contract. *Discourse: Studies in the Cultural Politics of Education*, 34(4), 599–610.
- Martin, D. B. (2015). The collective Black and Principles to Actions. *Journal of Urban Mathematics Education* 8(1), 17–23.
- Martin, D. B. (2019). Equity, inclusion, and antiblackness in mathematics education. *Race Ethnicity and Education*, 22(4), 459–478. <https://doi.org/10.1080/13613324.2019.1592833>
- McCloskey, A. V., & Norton, A. H. (2009). Using Steffe's advanced fraction schemes. *Mathematics Teaching in the Middle School*, 15(1), 44–50.
- McGee, E. O. & Martin, D. B. (2011). "You would not believe what I have to go through to prove my intellectual value!" Stereotype management among academically successful Black mathematics and engineering students. *American Educational Research Journal*, 48(6), 1347–1389. doi:10.3102/0002831211423972.
- Moll, L. C., & González, N. (2004). Engaging life: A funds of knowledge approach to multicultural education. In J. Banks & McGee Banks (Eds.), *Handbook of research on multicultural education* (Second edition) (pp. 699 – 715). NY: Jossey-Bass.
- Mukhopadhyay, S., Powell, A. B., & Frankenstein, M. (2009). An ethnomathematical perspective on culturally responsive mathematics education. In B. Greer, S. Mukhopadhyay, A. B. Powell, & S. Nelson-Barber (Eds.), *Culturally responsive mathematics education* (pp. 65 – 84). New York, NY: Routledge.
- National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all*. Reston, VA: NCTM.
- National Council of Teachers of Mathematics (2018). *Catalyzing Change in High School Mathematics: Initiating Critical Conversations*. Reston, VA: NCTM.
- National Council of Teachers of Mathematics (2020A). *Catalyzing Change in Early Childhood and Elementary Mathematics: Initiating Critical Conversations*. Reston, VA: NCTM.
- National Council of Teachers of Mathematics (2020B). *Catalyzing Change in Middle School Mathematics: Initiating Critical Conversations*. Reston, VA: NCTM.
- Ottmar, E. R., Rimm-Kaufman, S. E., Larsen, R. A., & Berry, R. Q., III (2015). Mathematical knowledge for teaching, standards-based mathematics teaching practices, and student achievement in the context of the responsive classroom approach. *American Educational Research Journal*, 52(4), 787-821.

Lamberg, T., & Moss, D. (2023). *Proceedings of the forty-fifth annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (Vol. 1). University of Nevada, Reno.